STATE OF TENNESSEE

DEPARTMENT OF ENVIRONMENT AND CONSERVATION

DIVISION OF UNDERGROUND STORAGE TANKS

TECHNICAL GUIDANCE DOCUMENT – 016

EFFECTIVE DATE – November 1, 2007

RE: MOBILE ENHANCED MULTI-PHASE EXTRACTION

I. General Guidance

A. Purpose

The purpose of this Technical Guidance Document (TGD) is to provide guidance for applying enhanced multi-phase extraction technology at petroleum underground storage tank (UST) sites. Mobile Enhanced Multi-phase Extraction (MEME), also known as dual-phase extraction or vacuum-enhanced extraction, utilizes high vacuum pressures and air flow rates to remove vapor phase, adsorbed, dissolved, and/or free phase volatile organic compounds from both the saturated and unsaturated zones in the subsurface. A mobile unit equipped with a high capacity vacuum pump is most commonly used.

MEME events may also be used to introduce co-solvents, oxygen, or surfactants into the subsurface to enhance the natural biodegradation of petroleum hydrocarbons; however, injection of any fluid requires prior approval from state and/or local underground injection programs. This type of event will require Division of Underground Storage Tanks (Division) approval and will result in the preparation and submittal of a Corrective Action Plan (CAP).

The Division will require an Application to Perform Mobile Enhanced Multi-Phase Extraction (MEME Application) be completed and submitted for an event with duration of four (4) to twenty-four (24) hours. Dual-phase, high vacuum extraction events exceeding twenty-four (24) hours will require Division approval and will result in the preparation and submittal of a CAP.

MEME events may be used to meet the following objectives at UST sites:

- Removal of free product; and/or,
- Collection of aquifer and substrate extraction data that will be used in the design of a corrective action system.

B. Fund Eligibility/Coverage

An eligible owner or operator conducting UST corrective actions is entitled to coverage of reasonable costs from the Tennessee Petroleum Underground Storage Tank Fund, subject to Rule 1200-1-15-.09(10)(a), which states:

> "Upon confirmation of a release in accordance with rule 1200-1-15-.05(3) or after a release from the UST system is identified in any other manner, owners and/or operators or petroleum site owners shall comply with the requirements of rule 1200-1-15-.06 as necessary to investigate the release, characterize the site and control any hazards posed by the release in order to stabilize the site, prevent significant risk to human health and safety, and/or continuing damage to the environment."

Therefore, failure to comply with the requirements of Rule 1200-1-15-.06 addressed in this TGD may result in the loss of Fund coverage.

C. Applicability

This revision replaces all previous versions and policies addressing MEMEs. Unless directed by the Division to do otherwise, this TGD applies to all sites where MEME technology is required.

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Attachments

MEME Application
MEME Report

Resources necessary to complete a MEME Application and Report

MEME Cost Proposal (Excel spreadsheet)
MEME Field Log (Excel spreadsheet)

These Excel® documents are available for download on the Division's website at http://state.tn.us/environment/ust/

II. Definitions

For the purposes of this TGD, the following definitions apply:

A. **Mobile Enhanced Multi-phase Extraction - Corrective Action Technology** (MEME-CAT) - An eight (8) to twenty-four (24) hour high vacuum extraction event on a monitoring and/or recovery well for the purpose of free product removal and to collect corrective action system design criteria.

B. **Mobile Enhanced Multi-phase Extraction - Observation Well** (MEME-OW) - A four (4) to eight (8) hour high vacuum extraction event on an observation well to remove free product and to monitor free product recharge.

III. Application

The Division will require a MEME application to be completed and submitted for an event with a duration of four (4) to twenty-four (24) hours. Dual-phase, high vacuum extraction events exceeding twenty-four (24) hours will require Division approval and will result in the preparation and submittal of a CAP.

IV. Placement of Extraction Device(s)

The volume of product, vapor, and water recovered greatly depends on the depth at which the extraction device is placed. Extraction device placement shall be based on the most recent aquifer data obtained prior to submitting the MEME Application. If the purpose of the MEME event is to extract free product, then appropriate adjustments to the extraction device depth shall be made during the MEME event to maximize free product removal.

V. MEME Event Specifications

The liquid recovery tank shall be empty of any liquid prior to beginning the MEME event.

The MEME Field Monitoring Log is an Excel® document and shall be used to record and report the field activities for the MEME event. During the MEME event, the parameters listed on the log shall be monitored at fifteen (15) minute intervals for the first two (2) hours, and at thirty (30) minute intervals thereafter for the next six (6) hours. For MEME events exceeding eight (8) hours, subsequent readings shall be collected at four (4) hour intervals. If an alteration in the event duration and/or monitoring interval is needed, then prior justification shall be submitted with the MEME Application.

The concentration (emission) readings shall be collected at the system outlet (stack) using a flame ionization detector (FID), thermal conductivity meter, or other instrument approved by the Division prior to its use. All instruments must be equipped with a condensate trap capable of removing moisture. The airflow rate shall be measured using a device capable of measuring velocity to an accuracy of +/- 5%. Vacuum readings on surrounding monitoring wells shall be recorded to determine the radius of influence. At a minimum, water level readings in all monitoring/recovery wells shall be taken before and after the event. All calculations shall be performed in accordance with Section VI, Reporting Requirements of TGD.

VI. Reporting Requirements

A report documenting the MEME event shall be completed and submitted by the established deadline in accordance with the attached MEME Report guidelines.

The equations used to complete the MEME Field Monitoring Log are included in Reference 1 - Emission Calculations and Equations

Reference 1 - Emission Calculations and Equations

Equation to determine flow in units of Dry Standard Cubic Feet per Minute (DSCFM):

Q_{std} = (60 sec/min) (1-B_{ws}) (V) (A) (528 ^oR / T_s); where,

Q_{std} = flow at DSCFM
B_{ws} = water vapor % by volume, high temperature psychrometric chart for air-water vapor mixtures in *Perry's Chemical Engineers' Handbook*, assume stack gas is saturated
V = velocity in ft/sec, obtain with hot wire anemometer or pitot tube
A = cross sectional area of discharge stack in square feet at the sampling location
T_s = stack temperature in degrees Rankin (^oR), $^oR = {}^oF + 460$

Equations to determine pollutant mass removal rate as carbon (PMR_c):

PPM_c = (PPM_{meas})(K)
C_{cm} = PPM_c (M_c / K_3)
C_c = C_{cm} (62.43 x 10^{-9} lb-m^3/mg-ft^3)
PMR_c = C_c (Q_{std}) (60 min/hr); where,

PPM_{meas} = obtained directly from instrument
K = number of carbons in calibration gas, methane K = 1, propane K = 3, hexane K = 6
C_{cm} = mg/dsm^3, mass concentration of Total Gaseous Non-methane Organic (TGNMO) emissions
PPM_c = PPM_v, volumetric concentration of TGNMO emissions as carbon, dry basis, at STP
M_c = 12.01 mg/mg-mole, molecular weight of carbon
K_3 = 24.07 $dsm^3/10^6$ mg-mole, mass to volume conversion factor at STP
C_c = lb/dscf, mass concentration of TGNMO emissions as carbon, dry basis, at STP
PMR_c = lb/hr, pollutant mass removal rate of TGNMO emissions

STATE OF TENNESSEE

DEPARTMENT OF ENVIRONMENT AND CONSERVATION

DIVISION OF UNDERGROUND STORAGE TANKS

APPLICATION TO PERFORM MOBILE ENHANCED MULTI-PHASE EXTRACTION (MEME)

Effective November 1, 2007

The underground storage tank owner/operator shall complete and submit an original MEME Application to the appropriate Environmental Field Office for approval thirty (30) days prior to performing the MEME event. A duplicate copy of the application shall be sent to the Nashville Central Office. Any proposed changes that deviate from the requirements set forth in Technical Guidance Document (TGD) - 016, should be discussed with the Division of Underground Storage Tanks (Division) case manager prior to submittal of the application. No activities associated with performing the MEME event shall be conducted **before** the application is Division approved.

THIS APPLICATION IS NOT COMPLETE UNLESS THE FOLLOWING DOCUMENTS ARE ATTACHED TO THE APPLICATION OR IN AN APPENDIX:

Attached (Yes/No)

A. **Properly completed signature page** (attach to the application) _____

B. **Scaled site map** _____

Site Map: Provide a contoured scaled site map that, at a minimum, depicts the location of tanks, product and vent lines, dispensers, buildings, subsurface structures, underground utilities, and soil borings/monitoring wells. Indicate former UST systems with a dashed line. The site map shall include a North arrow. The site map shall also depict the most recent soil and ground water COC concentrations that exceed the approved site-specific standards. Extraction wells and wells monitored during the MEME event shall be identified and labeled.

C. **Potentiometric Table** _____

D. MEME Wellhead Configuration Diagram _____

Provide a diagram detailing the configuration of the wellhead and down-hole extraction equipment

E. Cost proposal (Excel® format available on the Division's webpage) _____

Costs shall not exceed those identified in the current Reimbursement Guidance Document – 001 that is available on the Division's webpage.

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1. Date of Application: _____
2. Facility I.D. Number: _____
3. Facility Name: _____
4. Facility Address: _____

   _____
5. Responsible Party Name: _____
6. Responsible Party Address: _____

   _____
7. Corrective Action Contractor (CAC) responsible for oversight of MEME event:

   _____
8. CAC Address: _____

   _____
9. CAC Mobile Phone #: (_____)_____
10. MEME Contractor Name: _____
11. MEME Contractor Address: _____

    _____
12. MEME Contractor Mobile Phone #: (_____)_____

13. List the personnel that will be at the site, their job title, and anticipated time at the site:

Name	Billing Title	Time On-site (Hrs)

14. Type of Free Product: ☐ Gasoline ☐ Diesel ☐ Gasoline/Diesel
☐ Kerosene ☐ Waste Oil ☐ Other Explain: _____

15. Proposed date of MEME event: _____

16. Type of MEME Event requested: ☐ MEME-OW ☐ MEME-CAT

17. Proposed Duration of MEME event:
☐ Four (4) hour ☐ Eight (8) hour ☐ Twenty-four (24) hour

18. Describe the disposal method for the extracted fluids:
_____
_____
_____
_____

19. For any event that is expected to exceed 3,000-gallons of fluids, state how the fluids will be managed and disposed, including, but not limited to, applicable discharge permits, additional temporary storage tank, treatment with existing oil/water separator, etc.
_____
_____
_____
_____

20. Describe the equipment to be used during the event.
a. Type and horsepower of vacuum pump:_____
b. Vacuum capacity of pump (inches of Hg):_____
c. Cubic feet per minute (cfm) capability of pump:_____
d. Capacity of liquid recovery tank (gallons):_____

21. Describe the instruments that will be used to measure stack velocities, vacuum readings, and vapor concentration levels:
_____
_____
_____
_____

22. Describe the calibration procedures for the instruments listed in item #21:

23. List the well extraction order and connection configuration:

24. List the perimeter well(s) to be used for vacuum readings monitoring:

25. Describe the method for determining the vacuum radius of influence:

Signature Page

A signature page, as shown below shall be attached to the MEME Application. The page shall be signed by the owner/operator or petroleum site owner (or authorized representative within the organization), and either a licensed professional geologist under the Tennessee Geologist Licensure Act of 2007 (*T.C.A. §62-36-101 et seq*.) or a registered professional engineer under the Tennessee Architects, Engineers, Landscape Architects and Interior Designer Law and Rules (*T.C.A. §62-2-101 et seq*.).

We, the undersigned, certify under penalty of law, including but not limited to penalties for perjury, that the information contained in this application and on any attachments, is true, accurate and complete to the best of our knowledge, information, and belief. We are aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for intentional violations.

_____ _____

Tank Owner and/or Operator or
Petroleum Site Owner(Print name) Signature

Date_____ _____

Title (Print)

_____ _____ _____

P.E. or P.G. (Print name) Signature Date

_____

Tennessee Registration #

Note: Each of the above signatures shall be notarized separately with the following statement.

STATE OF _____ COUNTY OF _____

Sworn to and subscribed before me by _____on this date

_____. My commission expires _____.

_____ _____ _____

Notary Public (Print name) Signature Date

Stamp/Seal

STATE OF TENNESSEE

DEPARTMENT OF ENVIRONMENT AND CONSERVATION

DIVISION OF UNDERGROUND STORAGE TANKS

MOBILE ENHANCED MULTI-PHASE EXTRACTION (MEME) REPORT

Effective November 1, 2007

Instructions

The Mobile Enhanced Multi-Phase Extraction (MEME) Report is due within thirty (30) calendar days after the Responsible Party has performed the MEME event in accordance with Technical Guidance Document - 016. The MEME Report shall contain **all** data gathered during the MEME event. Environmental assessment activities and evaluation of the subsurface investigation shall be directed by a licensed professional geologist under the Tennessee Geologist Licensure Act of 2007 (*T.C.A. §62-36-101 et seq*.) or a registered professional engineer under the Tennessee Architects, Engineers, Landscape Architects, and Interior Designers Law and Rules (*T.C.A. §62-2-101 et seq*.).

Each section of the MEME report shall be prepared and assembled in the order presented within these guidelines. Text shall be provided explaining the associated tables and maps. All variations from the procedures detailed in the Environmental Assessment Guidelines (EAG) shall be justified. All maps shall be in appendices as required below. All maps shall be on 8.5 × 11 or 11 × 17 inch paper and include, at a minimum, a North arrow, legend, scale bar and figure number. The MEME report guidelines are intended to provide a structured outline. Any information that is not specifically requested but is relevant to the project shall also be included. The preparer shall assemble the required information in each section so as to provide a comprehensive document. All pages of the report, including the tables and figures, shall be consecutively numbered.

All correspondence, reports, laboratory analysis sheets, etc. shall contain the TN UST Facility ID Number. Photostatic copies of the laboratory analysis sheets are not acceptable unless the originals have previously been submitted in another report.

THIS REPORT IS NOT COMPLETE UNLESS THE FOLLOWING DOCUMENTS ARE ATTACHED TO THE REPORT OR IN AN APPENDIX:

Attached (Yes/No)

A. **Properly completed signature page** (attach to the report) _____

B. **Scaled site map** (update the site map submitted with the application) _____

C. **Two Potentiometric Maps** _____
(before and after event, only required for MEME-CAT or MEME-SIE)

D. **Scaled plan view map documenting the vacuum effect at the end of the MEME event** (see item #12) _____

E. **MEME Field Monitoring Log** _____
(include any subcontractor field log, if applicable)

F. **Updated Free Product Removal Table** _____

G. **Disposal Manifests** _____

H. **Copies of Permits** (air, water, etc.) _____

The following information shall be provided in the format specified below.

1. Date of report: _____

2. Facility ID #: _____

3. Facility name: _____

4. Facility address: _____

_____

5. Date of MEME event: _____

6. List the personnel at the site, their job title, and total time at the site:

Name	Billing Title	Time On-site (Hrs)

7. Type of free product recovered during the MEME event: _____

8. Gallons of free product in tank prior to beginning MEME event: _____

9. Gallons of free product in tank at the end of the MEME event: _____

10. Gallons of water in tank at the end of the MEME event: _____

11. The MEME Event Summary shall include all relevant facts and developments that occurred upon arrival and during the MEME event, including but not limited to, a discussion of the field operations, any actions taken to improve the extraction, any problems encountered during the MEME event, deviations from the work plan specified in the approved application, any data inconsistencies, and any other significant procedural and/or analytical details.

12. Describe the effect of the vacuum at the site during the MEME event, including the radius of influence to 0.1 inches of water vacuum.

13. Describe the drawdown effects at the site during the MEME event, including a cone of depression, if noted.

14. Free Product Removal Table

Complete the following table (an example is provided below). The free product location(s) that are included in the referenced table shall be depicted on the scaled site map. This referenced map shall be updated from the most recently submitted report.

Free Product Location	**Date**	**Product thickness (feet)**	**Product removed? (Y/N)**	**Gallons of free product removed during event**	**Cumulative gallons per location of free product removed**	**Gallons of water removed during event**
MW-1	6-1-07	2.6	Y	2	171	1
MW-1	7-15-07	1.3	Y	9		2
MW-1	8-12-07	1.6	Y (MEME)	150		360
MW-2	6-1-07	0.0	N	0	5	0
MW-2	7-15-07	0.7	Y	5		2
MW-2	8-12-07	0.0	N	0		0
Total gallons of product removed this event:				0		
Total cumulative gallons of product removed to date:					176	
Total gallons of water removed this event:						365

15. Describe the occurrence of free product at the site after the MEME event.

16. If free product was not removed at a specific location listed in the Free Product Removal Table above, then explain why the product was not removed.

17. Describe the method and location of disposal for the recovered free product, liquids, soils, pads, booms, etc. (attach disposal manifests in an appendix):

Signature Page

A signature page, as shown below shall be attached to the MEME Report. The page shall be signed by the owner/operator or petroleum site owner (or authorized representative within the organization), and either a licensed professional geologist under the Tennessee Geologist Licensure Act of 2007 (*T.C.A. §62-36-101 et seq*.) or a registered professional engineer under the Tennessee Architects, Engineers, Landscape Architects and Interior Designer Law and Rules (*T.C.A. §62-2-101 et seq*.).

We, the undersigned, certify under penalty of law, including but not limited to penalties for perjury, that the information contained in this report and on any attachments, is true, accurate and complete to the best of our knowledge, information, and belief. We are aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for intentional violations.

_____ _____

Tank Owner and/or Operator or
Petroleum Site Owner(Print name) Signature

Date_____ _____

Title (Print)

_____ _____ _____

P.E. or P.G. (Print name) Signature Date

_____

Tennessee Registration #

Note: Each of the above signatures shall be notarized separately with the following statement.

STATE OF _____ COUNTY OF _____

Sworn to and subscribed before me by _____on this date

_____. My commission expires _____.

_____ _____ _____

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Stamp/Seal